FWS National Wildlife Refuge System Wilderness Fellows

Report on Wilderness Character Monitoring

Seney Wilderness

Seney National Wildlife Refuge

Prepared by Rachael Carnes

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Photo credit: Dale Maxson, 2010

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INTRODUCTION TO THE PROJECT

This report provides a detailed summary of the baseline wilderness character assessment completed for the Seney Wilderness on the Seney National Wildlife Refuge (NWR), located in the eastern Upper Peninsula of Michigan. The wilderness character monitoring framework applied throughout this process was developed by an interagency wilderness team and is described in the Forest Service publication, *Keeping It Wild: an interagency strategy to monitor trends in wilderness character across the National Wilderness Preservation System* (Landres et al. 2008). The framework initiates a methodology for quantifying aspects of wilderness for long-term monitoring.

Many unique measures of wilderness character were created that are specifically relevant to the Seney Wilderness. However, every indicator within the framework must be represented by at least one measure, whether it is pertinent to a particular wilderness or not. The purpose of this is to ensure a comprehensive and consistent representation of wilderness status throughout U.S. Fish and Wildlife Service National Wildlife Refuge system lands.

The purpose of this report is multi-dimensional. It establishes a wilderness character monitoring program for the Seney Wilderness and provides baseline data for future trend analysis. An understanding of the information in this report may also aid resource specialists by informing management decisions within the Seney Wilderness. Finally, this report is meant to accompany and explain the quantitative results of Seney's wilderness character assessment that have been entered into a national wilderness character monitoring database.

SETTING OF THE REFUGE WILDERNESS

HISTORY OF WILDERNESS ESTABLISHMENT

In 1934, the Michigan Conservation Department recommended to the Federal Government that the Seney area be protected for wildlife. Seney NWR was then set aside by Executive Order No. 6724 of May 28, 1934 and Executive Order 7345 and Title VII of the Act of June 13, 1935. Physical development of Refuge land began soon after establishment. With the aid of the Civilian Conservation Corps, an intricate system of dikes, water control structures, ditches, and roads was built. Most of these are still in use today.

The Seney Wilderness Study Area was designated in accordance with The Wilderness Act of September 3, 1964 (Public Law 88-577), which required that every roadless area within the National Wildlife Refuge System of 5,000 acres or more be set aside for study to determine its suitability as a wilderness. Though considerable anthropogenic developments for waterfowl and other wildlife had been made on the Refuge, the portion that qualified for wilderness study was still largely undeveloped (with only the Walsh Ditch on the eastern edge and a few old logging roads on the western edge). This tract of land included many benchmark areas that had escaped turn-of-the-century logging and whose natural disturbance regimes were still relatively intact. The study area also included Seney's rare "String Bogs", which are low, flat areas with ridges covered in a boreal forest community and that run roughly parallel in formation from the northwest to the southeast.

The 25,150-acre Seney Wilderness proposal was included in the 1970 Omnibus Wilderness Act (Public Law 91-504). This Act was signed into law prior to the January 2, 1970 adjournment of the 91st session of Congress.

GEOGRAPHIC SETTING

Seney National Wildlife Refuge encompasses 95,238 acres of Schoolcraft County in the eastern Upper Peninsula of Michigan. The Refuge is bounded by highways M-28 and M-77 to the north and east, respectively. Seney NWR is located between the towns of Seney and Germfask, MI, which have <500 people combined. Over half (54%) of the total land area in the eastern U.P. is in public lands (CCP 2009, MIDNR). The three nearest major communities of >25,000 people are each over 80 miles away. The Seney Wilderness comprises 25,150 acres (or approximately 26% of the total acreage) in the western third of the Refuge (Seney NWR Comprehensive Conservation Plan 2009).

ECOLOGICAL SETTING

The eastern Upper Peninsula of Michigan has a lacustrine-influenced climate and is dominated by a glaciated landscape and a mosaic of forests and wetlands. This ecoregion is characterized by flat topography, open peatlands, forested lowland swamps, and extensive upland forests. Prior to European settlement, approximately 38% of this ecoregion was covered with mixed-conifer forests, with much of the remaining area comprised of shrub and open wetlands (Comer et al. 1995, Zhang et al. 2000). The distribution of these forests across the landscape was regulated primarily by the interaction of topography, soil moisture hydrology, and fire. Generally speaking, wildfires tend to burn more erratically and less frequently on ice-contact landforms than on dry, sandy outwash plains. As a result, many areas of the Refuge were historically dominated by large, interspersed mature red pine and eastern white pine (or mixed-pine) forests within a wetland matrix (Drobyshev et al. 2008a,b). While the area's land cover has basically maintained its overall species diversity, much of the composition and structure of the present-day forests (and likely wetlands) have been altered from their pre-European condition (Drobyshev et al. 2008a,b, Corace et al. *In Press*). For instance, it is estimated that < 1% of the historic primary white and red pine forests exist in the current regional landscape. Forest structure throughout the area, including the forests of Seney NWR, have been altered due to logging activities, ditching, farming, and fire suppression (Zhang et al. 2000, Drobyshev et al. 2008a,b).

Within the confines of a hierarchical ecological classification system, Seney NWR resides in a sub-subsection of the eastern Upper Peninsula called the Seney Sand Lake Plain (Albert 1995). This ecosystem covers 17,114 square miles, including all of Chippewa, Mackinac, Luce, Schoolcraft, Delta and Alger Counties, and portions of Menominee, Dickinson and Marquette Counties. The area is characterized by poorly drained embayments with beach ridges and depressions, sand spits, transverse sand dunes, and sand bars. Soil types in the area include peats, poorly drained sands, and excessively drained sands. Marshes, peatlands, and low productivity swamps were the predominant pre-settlement vegetation communities (Albert 1995). Today, landcover in the Seney Sand Lake Plain consists primarily of forest (67%) and wetlands (20%), with scattered agricultural (4%) and urban (2%) areas. The remaining 7 % of landcover consists of open grasslands, sparsely vegetated areas, beaches and rock areas. Seney NWR represents 11% of the Seney Sand Lake Plain (Corace et al. In Press).

Although, in a relative sense, change in historic land cover within the Seney Sand Lake Plain is much less than elsewhere in the Upper Midwest, the area has still experienced considerable change in forest composition and structure over the past century (Corace et al. *In Press*). In general, deciduous taxa (especially aspens and maples) have exhibited the greatest increase in dominance, while coniferous taxa (especially pines) have experienced the greatest decline. Increases in dominance have occurred primarily among shade-tolerant, fire-sensitive taxa (e.g., maple, American basswood, balsam fir), while decreases have been observed among species that are shade-intolerant or mid-tolerant and dependent on fire (e.g., aspens, pines). Land use change and associated modification of disturbance regimes are

likely strong drivers of the altered conditions described here. Extensive timber harvesting near the turn of the 20th century and human-induced deviations from the natural fire return cycle have been associated with these increases in shade-tolerant hardwoods and decreases in fire-dependent pine species (Drobyshev et al 2008a,b). Similarly, declines on other coniferous taxa (especially tamarack) in the Seney Sand Lake Plain are related to anthropogenic changes in hydrology, as this area was ditched for agricultural purposes, then diked for waterfowl habitat in the 1930s and 1940s (Losey 2003, Corace et al. *In Press*).

The Seney Sand Lake Plain is categorized into even finer-scale land type units within the National Hierarchical Framework of Ecological Units (Cleland et al. 1997). Ecological land classifications are used to identify, describe, and map progressively smaller areas of land with increasingly uniform ecological features. There are eight levels of Ecological Classification System (ECS) units in the United States (http://www.dnr.stat.mn.us/ecs/index.html). Of these, Land Type Associations (LTAs) are the next finer-resolution classification units within the Seney Sand Lake Plain. Seven different LTAs include parts of Seney NWR (See Map 1). LTAs are defined as units of a Subsection (in this case, the Seney Sand Lake Plain) that are defined using glacial landforms, bedrock types, topographic roughness, lake and stream distributions, wetland patterns, depth to ground water table, soil parent material, and pre-European settlement vegetation. The LTA is a common unit both for evaluating and applying results from research, as well as summarizing landscape characteristics and assessing the condition of resources (Almendinger et al. 2000). Many of the measures created in the process of wilderness character monitoring at Seney have been grounded in the LTA classification level.

The Seney Wilderness is comprised of the following three LTAs: Strangmoor Bog, Walsh Fen, and West Branch Manistique. The Strangmoor Bog covers approximately 57% of the total area of the Wilderness, the Walsh Fen LTA encompasses about 29%, and the West Branch Manistique LTA comprises 15% (See Map 1). The rarity and conservation priority of these individual LTAs is positively related to their prevalence within Seney's designated Wilderness. The Strangmoor Bog LTA covers over half of the Wilderness on its own, while producing the most unique plant communities within the landscape.

The LTA with the smallest area in the Wilderness is the West Branch Manistique LTA. Generally known as the "hardwoods portion" of the Wilderness, land cover in this area has historically been a mix of spruce-fir-cedar stands and beech-sugar maple-hemlock stands. The Walsh Fen LTA, on the other hand, was historically dominated by muskeg-bog, mixed conifer swamp, hemlock-yellow birch- stands, white and red pine stands, and shrubland. The third and largest LTA in Seney's Wilderness houses the Strangmoor Bog National Natural Landmark. The term Strangmoor (or "String") Bog refers to patterned terrain formed on glacial outwash plains; typified by long, string-like peatland swamps interspersed with mixed-conifer forests or pine "islands" growing on extinct sand dunes. String Bogs are typically found in the boreal ecoregions and are rarely found this far south (Heinselman 1965). Historically, this community inside the Seney Wilderness was dominated by muskeg-bog, with small "islands" of white and red pine forests.

Unlike the other two LTAs, the West Branch Manistique LTA is not significantly influenced by fire as a natural disturbance. Instead, smaller-scale disturbances, such as windfall of individual trees, influence composition and structure. However, Beech Bark Disease is present in this area and is taking a toll on American beech trees (Corace et al. 2009). Conversely, the Walsh Fen and Strangmoor Bog LTAs are both highly fire-dependent. In general, fire is crucial in these systems to set back succession and increase species diversity in low, wetland areas and to maintain existing conditions in the pine island communities. The natural fire return cycle for this area (which is 50-60 years) has remained largely intact

within the ecosystems of Seney's Wilderness (Drobyshev 2008a,b). This disturbance regime is considered "stand maintaining" and not "stand replacing." Its communities are largely old growth, virgin forest dominated by long-lived (>400 years) species and can therefore be viewed as a benchmark condition for the general region.

The West Branch Manistique LTA has been altered by logging activities as recently as the early 1970s. The bog-like nature of the other two LTAs made them much more difficult to reach, and they were therefore protected from such activities. The Walsh Fen LTA was probably logged in a few confined areas, while the Strangmoor Bog was basically left untouched.

REFUGE PURPOSES

Seney NWR was originally established as a "refuge and breeding ground for migratory birds and other wildlife" (Executive Order 7246). Under the Migratory Bird Conservation Act, it was also promised "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds". Lastly, under the National Wildlife Refuge System Administration Act, every Refuge was purposed for the "conservation, management, and restoration of the fish, wildlife, and plant resources and their habitats for the benefit of present and future generations of Americans".

The present-day Vision Statement from the CCP (2009) states that Seney's management will be aimed towards: making management decisions in the best interest of wildlife and their habitats, maintaining the rich mosaic of Seney's habitats within its larger ecoregion, prioritizing species and ecosystems that are of regional concern and are suited to Seney's unique environment, maintaining Refuge-level biological diversity while preserving ecological integrity, and managing for a variety of ecological conditions including wilderness character.

The stated goals of the official management alternative chosen in Seney's CCP (2009) are three-fold. In the management of wildlife, the goal is to preserve, conserve, and restore the diversity of wildlife native to the eastern U.P. As far as habitat management, the goal is to conserve the range of habitat conditions now found within the Refuge and restore pre-European conditions when and where possible. In managing for public use, the goal at Seney is to provide visitors and the surrounding community with opportunities to experience quality wildlife-dependent activities and to understand the rich mosaic of wildlife and habitats found within the eastern U.P.

STAFF CONSULTED

The following is a listing of the names and titles of Seney NWR staff members consulted in this process:

Mark Vaniman, Refuge Manager
Greg McClellan, Deputy Manager
Greg Corace, Forester and Acting Biologist
Gary Lindsay, Fire Management Officer

PROCESS USED FOR SELECTING MEASURES

Wilderness Character Monitoring requires the identification of quantifiable measures that reflect wilderness character. Changes in the values of these measures over time will be used as an index to evaluate trends in the four primary wilderness qualities: Untrammeled, Natural, Undeveloped, and

Opportunities for Solitude/Primitive and Unconfined Recreation. The changes in the values of these measures are supposed to correlate with improvements or degradations to wilderness character.

In order to identify a suite of relevant and feasible wilderness character monitoring measures for the Seney Wilderness, I began by learning as much as possible about the wilderness. I reviewed many documents discussing Seney NWR and the Seney Wilderness specifically; relating to its history, management, past and possible sources of degradation, and relevant ecological research. The purpose of this process was not only to learn about the wilderness, but also to start accumulating knowledge of available data and data sources.

During this time, I attended a Refuge staff meeting to explain the process and objectives of my project. I had individual meetings with Mark Vaniman (Refuge Manager) and Dr. Greg Corace (Refuge Forester) to discuss my project in more detail. Under the guidance of Dr. Corace, I also went out on five separate trips to the wilderness and wilderness-adjacent areas of the Refuge in order to gain more of an understanding of its various community types and disturbance regimes.

With reasonable knowledge of the Seney Wilderness and the available data, I began developing a rough draft of possible measures. I used the measures from *Keeping It Wild* as a guideline in order to ensure that I was capturing as many characteristics of wilderness as possible. I expanded upon these measures in order to incorporate issues of specific relevance or concern to the Seney Wilderness. This first draft of measures was submitted to both Mark Vaniman and Greg Corace for review. I then met with Dr. Corace to discuss his comments and ensure my understanding of his suggestions.

I then edited the first draft of measures and incorporated Refuge staff suggestions. I also reworded, disposed of, or changed measures based on further knowledge of the scope of the available dataset. I then completed prioritization exercises for every potential measure, allowing me to rank them based on their importance, vulnerability, reliability, and reasonableness. This process allowed me to edit the set of measures again; focusing, simplifying, and prioritizing specific attributes. The resulting list of measures was again submitted for approval by Greg Corace and discussed in a brief meeting. Once the measures were finalized, I entered them into a national wilderness character monitoring database application and began collecting data to populate this database.

MEASURES USED

UNTRAMMELED QUALITY

The document *Keeping It Wild* states the following regarding the untrammeled quality: The Wilderness Act states that wilderness is “an area where the earth and its community of life are untrammeled by man,” and that “generally appears to have been affected primarily by the forces of nature.” In short, wilderness is essentially unhindered and free from modern human control or manipulation. This quality is degraded by modern human activities or actions that control or manipulate the components or processes of ecological systems inside the wilderness.

Monitoring question: What are the trends in actions that control or manipulate the “earth and its community of life” inside wilderness?

Indicator: Actions authorized by the Federal land manager that manipulate the biophysical environment

Measure 1: Number of actions taken to manage invasive species

Description: Monitored annually. This is a count of the number of actions taken to manage any indigenous or non-indigenous invasive species. This measure should include all applications of pesticide or herbicide, mechanical removal, and/or the use of biological control agents that occur inside wilderness boundaries. In general, the untrammeled quality would be degraded if the number of actions increases.

An "action" should be determined according to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*. The guidelines are as follows:

A single action occurring at a single location = 1 action
A single action occurring at multiple locations= 1 action
Multiple actions occurring at a single location= multiple actions
Multiple actions occurring at multiple locations= multiple actions
An action occurring within in a single fiscal year= 1 action
An action spans multiple fiscal years without interruption= 1 action
An action spans multiple fiscal years with interruption= multiple actions

Context: There is no management of invasive species inside the wilderness at present. Studies have shown that invasive plant species are not present in quantities that call for management action at this time, however Beech Bark Disease (caused by an exotic scale insect and associated fungus) is an issue in the western segment of the wilderness. In the future, if the extent or magnitude of invasive species located in wilderness increases, management actions may include spraying with herbicide or pesticide, prescribed burns, or manual removal. It is crucial to note the benefit of such actions to the natural quality of wilderness. However, it is also important to monitor the frequency and intensity of these projects, as they represent human control of wilderness despite their beneficial outcomes.

Relevance to the indicator: Wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. There are certainly valid reasons behind many management and restoration projects. However, the purposeful manipulation of individual plant species or plant communities by federal land managers inside wilderness disturbs its unadulterated state. The purpose, frequency, and intensity of each of these projects must be considered carefully in regard to its effect on wilderness character and this warrants monitoring.

Data source: 2011 Invasive Plant Management Report, CCP, MNFI Strangmoor Bog Assessment, Rapid Ecological Assessment

Process used to compile or gather the data: Review of the documents listed above.

Significant change: Any change in this measure will be considered significant.

Data adequacy: Medium. There were significant data (in the form of reports from multiple government agencies) on the West Branch Manistique and Strangmoor Bog sections of the wilderness, but information was somewhat lacking in regards to the Walsh Fen section.

Measure 2: Number of naturally-started fires that received a suppression response
Description: Monitored every 5 years. This measure is a count of the number of fires that ignited from natural causes inside the wilderness and were then suppressed by any method of human interference. This number should be summed over the five-year time interval. In general, the untrammeled quality would be degraded if the number of suppressed fires increases.

Context: This measure calls for the number of naturally-started fires that received a suppression response rather than the percent of naturally-started fires. It was worded this way because there are most likely many natural fires that start in the wilderness but cover only a small area before they burn themselves out. These fires would remain completely undetected by Refuge staff. In the past, there have been several naturally-started fires in wilderness that we are aware of that were suppressed by management (1 in 1976 and 2 in 1988), but there have also been instances where fires were allowed to burn. The management response depends on the magnitude and nature of the fire, with potential safety issues playing a key role in the decision-making process.

Relevance to the indicator: Wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. There are certainly valid reasons behind many fire management or fire regime restoration projects. However, the purposeful manipulation of natural fire disturbance regimes by federal land managers inside wilderness disturbs its unadulterated state. Such projects must be considered carefully in regard to their effect on wilderness character and this warrants monitoring.

Data source: Annual narratives, Refuge staff, Drobyshev papers, Fire Management Plan

Process used to compile or gather the data: Review of the documents listed above.

Significant change: Any change in this measure will be considered significant.

Data adequacy: Medium. We cannot necessarily be certain that fire suppression activities did not occur in a particular year just because the annual narratives make no mention of it.

Measure 3: Number of prescribed burns
Description: Monitored every 5 years. This measure is a count of the number of prescribed burn operations that occur on any portion of designated wilderness. This number will be summed over the 5 year time interval. In general, the untrammeled quality would be degraded if the number of prescribed burns increases.

Context: Prescribed burns have not historically occurred on the Seney Wilderness, but it has been stated as a possible management option in the future. Significant research has been conducted at Seney to reconstruct its fire history, and it should be noted that prescribed burns would be used only to restore a more historically natural disturbance regime. However, despite the beneficial outcomes of prescribed burns in wilderness, they are still a very clear example of human control and must be very carefully

considered. If they take place in the future, it has been stated that the minimum tools necessary will be used.

Relevance to the indicator: Wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. There are certainly valid reasons behind many fire management or fire regime restoration projects. However, the purposeful manipulation of fire by federal land managers inside wilderness disturbs its unadulterated state. Such projects must be considered carefully in regard to their effect on wilderness character and this warrants monitoring.

Data source: Annual narratives, Refuge staff, Drobyshev papers

Process used to compile or gather the data: Review of the documents listed above.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Measure 4: Number of actions taken to restore natural hydrology of the wilderness

Description: Monitored annually. This measure should be a count of all actions taken, both inside and adjacent to wilderness, with the purpose of restoring natural hydrological patterns to the wilderness and adjacent wetlands. This includes activities such as installing ditch plugs or water control structures, digging spillways in dikes, ditch plug removal, ditch filling, etc. An "action" should be determined by following guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*. See Measure 1 for details regarding the tallying of actions. In general, the untrammeled quality would be degraded if the number of actions increases.

Context: The largest wetland drainage project in Michigan was initiated in 1912 near the town of Seney in the eastern Upper Peninsula of Michigan. This project included the construction of a series of drainage ditches intended to prepare the land for agricultural use. The largest of these ditches was the 22 mile-long Walsh Ditch, 6 miles of which runs north-south through the eastern side of the Seney Wilderness. In 2002 and 2005, a series of earthen ditch plugs were installed along the length of the ditch found within Seney NWR (some of which are inside the Seney Wilderness) in an attempt to restore the hydrology and ecological integrity of the affected wetlands and streams. So far, actions pertinent to this measure have been constrained to the installation of these ditch plugs. However, further actions may be taken in the future to restore the natural wetland hydrology of the area. While these actions do technically trammel the wilderness, it should be kept in mind that this quality is being degraded for the benefit of the natural quality of wilderness. The restoration of wetlands is a highly respectable endeavor; both for the benefit of wilderness character and for overall landscape ecosystem health. Moreover, the Refuge has worked with organizations such as the *Wilderness Society* throughout the NEPA process for approval of these actions.

Relevance to the indicator: Wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. The Seney Wilderness was designated as an altered landscape, with the Walsh drainage ditch running a full six miles within its boundaries. Actions to reverse the damage from this ditch are certainly valid management decisions and restoring wetlands is a worthy management goal. However, these actions also involve a purposeful manipulation

of wilderness with an intent to alter its designated state, often with the use of heavy machinery. This clearly disturbs the unadulterated state of the wilderness. Such projects must be considered carefully in regard to their effect on wilderness character and this warrants monitoring.

Data source: Environmental Assessment of Marsh and Walsh Creek Restoration, S.P. Welsh thesis

Process used to compile or gather the data: Review of the documents listed above.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Measure 5: Number of actions taken that influence animal populations
Description: Monitored annually. This measure is a count of all actions that manipulate or influence animal species or populations within wilderness in any way. This includes actions performed for research or survey purposes; reintroduction, introduction or supplementation of wildlife species; removal or culling of animals; or the manipulation of habitat for wildlife. An "action" should be determined by following the guidelines set forth in the Forest Service *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*. See Measure 1 for details regarding the tallying of actions. In general, the untrammeled quality would be degraded if the number of actions increases.

Context: At present, this is not an issue in the Seney Wilderness. Given inevitable changes in management and the research-oriented atmosphere at Seney, however, there is potential for such actions to occur in the future.

Relevance to the indicator: Wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. There are certainly valid reasons behind many monitoring, research, or management projects. However, the purposeful manipulation of animal species or populations by federal land managers inside wilderness disturbs its unadulterated state. The purpose, frequency, and intensity of each of these projects must be considered carefully in regard to its effect on wilderness character and this warrants monitoring.

Data source: Professional judgment

Process used to compile or gather the data: Personal communications with Refuge staff.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Indicator: Actions **not** authorized by the Federal land manager that manipulate the biophysical environment

Measure 6: Number of known incidents of unauthorized actions that influence the biotic and/or abiotic community inside wilderness

Description: Monitored annually. This measure is a count of the number of unauthorized or illegal actions taken that manipulate plants, animals, water, soil, or fire inside wilderness. This measure should include all activities not authorized by the federal land manager that influence the natural environment of the wilderness. Examples of such actions include poaching; fishing; hunting outside designated seasons; seed, plant, or animal harvesting; planting, etc. An "action" should be determined according to the guidelines set forth on page 55 of the Forest Service *Technical Guide for Monitoring Selected Conditions Related to Wilderness Character*. See Measure 1 for details regarding the tallying of actions. In general, the untrammeled quality would be degraded if the number of actions increases.

Context: As far as Refuge staff is aware of, there are currently no unauthorized actions taking place inside the Seney Wilderness that could potentially influence the natural community of life. Such activities have never been an issue at Seney in the past and are not predicted to be an issue in the foreseeable future. This measure was included for the purpose of representing this indicator within the wilderness character monitoring framework.

Relevance to the indicator: Wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. Unauthorized or illegal activities by outside parties can alter natural communities and trammel wilderness. These actions disturb the unadulterated state of wilderness and degrade wilderness character. While the federal land manager often has little control over such actions, the unauthorized manipulation of wilderness populations or communities must be taken very seriously and necessitates monitoring.

Data source: Professional judgment

Process used to compile or gather the data: Personal communications with Refuge staff.

Significant change: Any change in this measure will be considered significant.

Data adequacy: Medium. The number of illegal and/or unauthorized activities occurring within wilderness is inherently difficult to keep track of with perfect accuracy. It is unrealistic to assume Refuge staff can be aware of any and all unauthorized actions taking place inside wilderness.

NATURAL QUALITY

The document *Keeping It Wild* states the following regarding the natural quality: The Wilderness Act states that wilderness is “protected and managed so as to preserve its natural conditions.” In short, wilderness ecological systems are substantially free from the effects of modern civilization. This quality is degraded by intended or unintended effects of modern people on the ecological systems inside the wilderness since the area was designated.

Monitoring question: What are the trends in terrestrial, aquatic, and atmospheric natural resources inside wilderness?

Indicator: Plant and animal species and communities

Measure 7: Number of indigenous and/or non-indigenous invasive species

Description: Monitored every five years. This measure is a count of the number of invasive plant or animal species existing inside wilderness. The count should include all invasive plants, fungi, bacteria, insects, mammals, etc. In general, the natural quality would be degraded if the number of invasive species increases.

Context: There are only five known invasive species in the wilderness as of the date of this report. Studies have shown that invasive plant species are not present in quantities that call for management action at this time, however Beech Bark Disease (caused by an exotic scale insect and associated fungus) is an issue in the western segment of the wilderness. There is always a risk of new invasive species entering the wilderness, or of those that are already there spreading and becoming a more significant threat to native communities.

Relevance to the indicator: The Seney Wilderness is home to many unique and/or rare native plant species. However, like many other wild places, it is also at risk of invasive species disturbance, as certain indigenous and non-indigenous invasive species are present in small populations. The proliferation of invasive species inside the wilderness threatens to diminish or extinguish populations of native plant species and communities. It is essential to monitor the status of invasive species in order to ensure the health of native species populations.

Data source: Rapid Ecological Assessment, MNFI Ecological Community Field Survey, Seney CCP, 2011 Invasive Plant Management Report

Process used to compile or gather the data: Review of the documents listed above.

Significant change: Any change in this measure will be considered significant.

Data adequacy: Medium. Other than the professional judgment of Refuge staff members, there was not very much data available for the Walsh Fen portion of the wilderness.

Measure 8: Dominant tree species within West Branch Manistique LTA

Description: Monitored every ten years. This measure is confined to one of the three Land Type Associations (LTAs) comprising the Seney Wilderness. The basal area of various tree species was calculated in feet squared per acre. The dominant tree species is that with the highest basal area in a defined geographic unit (in this case the section of wilderness corresponding to the West Branch Manistique LTA). In general, the natural quality would be degraded if the dominant tree species changes.

Context: The West Branch Manistique LTA is known as the “hardwoods portion” of the Seney Wilderness. Sugar maple has most likely always been the dominant overstory tree species within this LTA, just as it is today. However, the extent of its dominance may suggest some risk of eventual homogenization. That being said, the dominance of sugar maple should be considered natural, and a deviation from this dominance should be considered a degradation of the natural quality. However, this measure is intended to leave flexibility as far as the exact basal area of sugar maple, acknowledging the natural range of variation in such processes and recognizing that some degree of decreased basal area would be healthy for the system.

Relevance to the indicator: Seney’s unique ecosystems have a great deal to do with its federal wilderness designation. The status of these systems is therefore crucial to the natural quality of Seney’s

wilderness character. However, the health of any community or habitat type is very difficult to quantify. The use of proxy measures as trustworthy replacements for a long list of more specific measures is therefore a popular method of data acquisition. Though this measure is an admittedly simplified representation, it is meant to serve as an efficient proxy of community health within the West Branch Manistique LTA.

Data source: Rapid Ecological Assessment

Process used to compile or gather the data: Review of the above document.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Measure 9: Percent wetland land cover within Strangmoor Bog LTA

Description: Monitored every ten years. This measure is confined to one of three Land Type Associations (LTAs) comprising the Seney Wilderness. It is meant to capture the percent of Strangmoor Bog land cover that is classified as “wetland”. In general, the natural quality would be degraded if the percent of wetland land cover within the Strangmoor Bog LTA decreases.

Context: The measures for percent wetland land cover and percent forest land cover within the Strangmoor Bog LTA are meant to be compared in order to monitor the LTA's potential change in composition due to wetland restoration activities, etc. Actions taken to restore wetland in the area are being considered under the untrammeled quality, and it is important to also capture the benefits of these actions under the natural quality of wilderness. However, there are no current research projects that directly focus on studying the extent of wetland restoration inside the wilderness. This measure is therefore meant to serve as somewhat of a proxy, using data available at a national scale from USGS. According to this data, 98% of Strangmoor Bog land cover is currently classified as “wetland”.

Relevance to the indicator: Seney’s unique ecosystems have a great deal to do with its federal wilderness designation. The status of these systems is therefore crucial to the natural quality of Seney’s wilderness character. However, the health of any community or habitat type is very difficult to quantify. The use of proxy measures as trustworthy replacements for a long list of more specific measures is therefore a popular method of data acquisition. Though this measure is an admittedly simplified representation, it is meant to serve as an efficient proxy of community health within the Strangmoor Bog LTA.

Data source: 2006 NLCD

Process used to compile or gather the data: Calculations for this measure should be completed using ArcGIS software and the most recent National Land Cover Dataset (NLCD) available from USGS. Land cover types 11, 90, and 95 were reclassified as "wetland". The area covered by wetland land cover was divided by the total area of the LTA, and then multiplied by 100 to obtain a percentage.

Significant change: A 5% change in this measure will be considered significant.

Data adequacy: Medium. The NLCD from USGS is a widely-used and accurate dataset, but it is not always detailed enough to capture all the subtle landscape heterogeneity that can occur at finer-scale resolutions.

Measure 10: Percent forest land cover within Strangmoor Bog LTA

Description: Monitored every ten years. This measure is confined to one of three Land Type Associations (LTAs) comprising the Seney Wilderness. It is meant to capture the percent of Strangmoor Bog land cover that is classified as “forest”. In general, the natural quality would be degraded if the percent of forest land cover within the Strangmoor Bog LTA increases.

Context: The measures for percent wetland land cover and percent forest land cover within the Strangmoor Bog LTA are meant to be compared in order to monitor the LTA's potential change in composition due to wetland restoration activities, etc. Actions taken to restore wetland in the area are being considered under the untrammeled quality, and it is important to also capture the benefits of these actions under the natural quality of wilderness. However, there are no current research projects that directly focus on studying the extent of wetland restoration inside the wilderness. This measure is, therefore, meant to serve as somewhat of a proxy, using data available at a national scale from USGS. According to this data, 2% of Strangmoor Bog land cover is currently classified as “forest”.

Relevance to the indicator: Seney’s unique ecosystems have a great deal to do with its federal wilderness designation. The status of these systems is therefore crucial to the natural quality of Seney’s wilderness character. However, the health of any community or habitat type is very difficult to quantify. The use of proxy measures as trustworthy replacements for a long list of more specific measures is therefore a popular method of data acquisition. Though this measure is an admittedly simplified representation, it is meant to serve as an efficient proxy of community health within the Strangmoor Bog LTA.

Data source: 2006 NLCD

Process used to compile or gather the data: Calculations for this measure should be completed using ArcGIS software and the most recent National Land Cover Dataset (NLCD) available from USGS. Land cover types 41, 42, and 43 were reclassified as "forest". The area covered by forest land cover was divided by the total area of the LTA, and then multiplied by 100 to obtain a percentage.

Significant change: A 5% change in this measure will be considered significant.

Data adequacy: Medium. The NLCD from USGS is a widely-used and accurate dataset, but it is not always detailed enough to capture all the subtle landscape heterogeneity that can occur at finer-scale resolutions.

Measure 11: Percent wetland land cover within Walsh Fen LTA

Description: Monitored every ten years. This measure is confined to one of three Land Type Associations (LTAs) comprising the Seney Wilderness. It is meant to capture the percent of Walsh Fen land cover that is classified as “wetland”. In general, the natural quality would be degraded if the percent of wetland land cover within the Walsh Fen LTA decreases.

Context: The measures for percent wetland land cover and percent forest land cover within the Walsh Fen LTA are meant to be compared in order to monitor the LTA's potential change in composition due to

wetland restoration activities, etc. Actions taken to restore wetland in the area are being considered under the untrammeled quality, and it is important to also capture the benefits of these actions under the natural quality of wilderness. However, there are no current research projects that directly focus on studying the extent of wetland restoration inside the wilderness. This measure is, therefore, meant to serve as somewhat of a proxy, using data available at a national scale from USGS. According to this data, 86% of Walsh Fen land cover is currently classified as “wetland”.

Relevance to the indicator: Seney’s unique ecosystems have a great deal to do with its federal wilderness designation. The status of these systems is therefore crucial to the natural quality of Seney’s wilderness character. However, the health of any community or habitat type is very difficult to quantify. The use of proxy measures as trustworthy replacements for a long list of more specific measures is therefore a popular method of data acquisition. Though this measure is an admittedly simplified representation, it is meant to serve as an efficient proxy of community health within the Walsh Fen LTA.

Data source: 2006 NLCD

Process used to compile or gather the data: Calculations for this measure should be completed using ArcGIS software and the most recent National Land Cover Dataset (NLCD) available from USGS. Land cover types 11, 90, and 95 were reclassified as "wetland". The area covered by wetland land cover was divided by the total area of the LTA, and then multiplied by 100 to obtain a percentage.

Significant change: A 5% change in this measure will be considered significant.

Data adequacy: Medium. The NLCD from USGS is a widely-used and accurate dataset, but it is not always detailed enough to capture all the subtle landscape heterogeneity that can occur at finer-scale resolutions.

Measure 12: Percent forest land cover within Walsh Fen LTA

Description: Monitored every ten years. This measure is confined to one of three Land Type Associations (LTAs) comprising the Seney Wilderness. It is meant to capture the percent of Walsh Fen land cover that is classified as “forest”. In general, the natural quality would be degraded if the percent of forest land cover within the Walsh Fen LTA increases.

Context: The measures for percent wetland land cover and percent forest land cover within the Walsh Fen LTA are meant to be compared in order to monitor the LTA's potential change in composition due to wetland restoration activities, etc. Actions taken to restore wetland in the area are being considered under the untrammeled quality, and it is important to also capture the benefits of these actions under the natural quality of wilderness. However, there are no current research projects that directly focus on studying the extent of wetland restoration inside the wilderness. This measure is, therefore, meant to serve as somewhat of a proxy, using data available at a national scale from USGS. According to this data, 13% of Walsh Fen land cover is currently classified as “forest”.

Relevance: Seney’s unique ecosystems have a great deal to do with its federal wilderness designation. The status of these systems is therefore crucial to the natural quality of Seney’s wilderness character. However, the health of any community or habitat type is very difficult to quantify. The use of proxy measures as trustworthy replacements for a long list of more specific measures is therefore a popular method of data acquisition. Though this measure is an admittedly simplified representation, it is meant to serve as an efficient proxy of community health within the Walsh Fen LTA.

Data source: 2006 NLCD

Process used to compile or gather the data: Calculations for this measure should be completed using ArcGIS software and the most recent National Land Cover Dataset (NLCD) available from USGS. Land cover types 41, 42, and 43 were reclassified as "forest". The area covered by forest land cover was divided by the total area of the LTA, and then multiplied by 100 to obtain a percentage.

Significant change: A 5% change in this measure will be considered significant.

Data adequacy: Medium. The NLCD from USGS is a widely-used and accurate dataset, but it is not always detailed enough to capture all the subtle landscape heterogeneity that can occur at finer-scale resolutions.

Indicator: Physical resources

Measure 13: Air quality
All data for air quality measures will be monitored and entered by officials with the FWS I&M Program.

Monitoring question: What are the trends in terrestrial, aquatic, and atmospheric natural processes inside wilderness?

Indicator: Biophysical processes

Measures 14-16: Climate change measures
Description: Monitored every five years. A suite of three weather data measures was used in an attempt to gather information on climate change influences at a local level. Each measure utilizes data recorded by the Remote Automated Weather Station (RAWS), located in Seney, MI. These measures are: mean summer temperature, mean winter temperature, and total annual precipitation. Summer was defined as the months of June, July, and August. Winter was defined as the months of December, January, and February. Mean summer and winter temperatures were calculated for each year. These seasonal means were then averaged over a five-year time interval. Since the year changes in the middle of the winter season, mean winter temperatures for any given year were calculated using data from December of the previous year and data from January and February of the target year. Total precipitation was calculated for each year and then these totals were also averaged over a five-year time interval. In general, the natural quality would be degraded if mean summer or winter temperatures increase or if total annual precipitation increases.

Context: It is predicted that Michigan will see a rise in winter temperatures of 5-10 degrees F and a rise in summer temperatures of 7-13 degrees F by the end of this century. Other climate change indicators for Michigan include an increase in winter precipitation of 5-25% and an increase in the frequency of extreme weather events. By using data from the Seney, MI RAWS station, these measures are meant to be an efficient way to monitor climate-related data. Data is accessible no earlier than November of 2002, so it was not possible to take five-year averages for time intervals previous to the current one (2007-2011).

Relevance to the indicator: Wilderness is set aside to preserve its natural conditions, but climate change has undeniable repercussions for natural system functioning. Attempting to monitor climate change and its widespread effects on wildlife is a national priority for many organizations, but there is no set protocol for how to do this in a cohesive manner. While the weather data measures described here are admittedly simplified proxies for representing climate change, they are an efficient means for Refuge staff to gather data directly linked to climate change and weather patterns.

Data source: RAWS weather data.

Process used to compile or gather the data: Excel analysis of weather data records.

Significant change: Any change in these measures will be considered significant, since most aberrations will be averaged out.

Data adequacy: Medium. This was calculated using RAWS weather data from Seney, MI. The dataset was missing 51 days of data throughout the 5 year time interval.

Measure 17: Deviation from the pre-European-settlement fire return interval

Description: Monitored every ten years. The pre-European settlement (1707-1859) fire return interval for this specific area was calculated to be 32.7 years. The current (1936-2006) fire return interval was calculated to be 18.5 years. The difference between the historic and current fire return interval was calculated for this measure. In general, the natural quality would be degraded if the deviation increases.

Context: Historically speaking, the natural fire regime and its various disturbance patterns have had a very significant impact on shaping the natural landscape in this part of the country. Due to its immense importance for management here at Seney, the fire history within various components of the Seney NWR was reconstructed in a 2006 study. Fifteen data plots for this study were located in the Seney Wilderness. The results of this study have made it feasible for management decisions regarding fire to be informed by historic data. This is one of two measures being recorded so as to provide an unbiased representation of whether the fire regime in wilderness is following its natural, historic patterns. At present, the difference between the historic and current fire return interval is 14 years.

Relevance to the indicator: Wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. There are certainly valid reasons behind many fire management or fire regime restoration projects. However, the landscape at Seney NWR, and in the Seney Wilderness specifically, was highly influenced by natural historic fire regimes. These historic disturbance regimes are a crucial component of Seney's natural quality and therefore necessitate monitoring.

Data source: Drobyshev, I. et al. 2008. Pre- and post-European settlement fire history of red pine-dominated forest ecosystems of Seney National Wildlife Refuge, Upper Michigan. ***Canadian Journal of Forest Research*** 38:2497-2514.

Process used to compile or gather the data: Review of the above document.

Significant change: Given the unpredictable nature of fire and the large natural range of variation of fire regimes, a 50% change in this measure will be considered significant.

Data adequacy: High

Measure 18: Deviation from the pre-European-settlement fire cycle
Description: The pre-European settlement (1707-1859) fire cycle for this specific area was calculated to be 144 years. The current (1936-2006) fire cycle was calculated to be 148 years. The difference between the historic and current fire cycle was calculated for this measure. In general, the natural quality would be degraded if the deviation increases.

Context: Historically speaking, the natural fire regime and its various disturbance patterns have had a very significant impact on shaping the natural landscape in this part of the country. Due to its immense importance for management here at Seney, the fire history within various components of the Seney NWR was reconstructed in a 2006 study. Fifteen data plots for this study were located in the Seney Wilderness. The results of this study have made it feasible for management decisions regarding fire to be informed by historic data. This is one of two measures being recorded so as to provide an unbiased representation of whether the fire regime in wilderness is following its natural, historic patterns. At present, the difference between the historic and current fire cycle is only 4 years.

Relevance to the indicator: Wilderness, by definition, is land where ecological functions have been allowed to operate without human manipulation. It is a place where natural conditions prevail and we, as humans, must accept the results with interest and humility. There are certainly valid reasons behind many fire management or fire regime restoration projects. However, the landscape at Seney NWR, and in the Seney Wilderness specifically, was highly influenced by natural historic fire regimes. These historic disturbance regimes are a crucial component of Seney's natural quality and therefore necessitate monitoring.

Data source: Drobyshev, I. et al. 2008. Pre- and post-European settlement fire history of red pine-dominated forest ecosystems of Seney National Wildlife Refuge, Upper Michigan***. Canadian Journal of Forest Research*** 38:2497-2514.

Process used to compile or gather the data: Review of the above document.

Significant change: Given the unpredictable nature of fire and the large natural range of variation of fire regimes, a 50% change in this measure will be considered significant.

Data adequacy: High

UNDEVELOPED QUALITY
The document *Keeping It Wild* states the following regarding the undeveloped quality: The Wilderness Act states that wilderness is "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation," "where man himself is a visitor who does not remain" and "with the imprint of man's work substantially unnoticeable." This quality is degraded by the presence of structures, installations, habitations, and by the use of motor vehicles, motorized equipment or mechanical transport that increases people's ability to occupy or modify the environment.

Monitoring question: What are the trends in non-recreational development inside wilderness?

Indicator: Non-recreational structures, installations, and developments

Measure 19: Number of administrative installations
Description: Monitored every five years. This measure is a count of the number of signs, posts, gates, and other administrative structures inside wilderness boundaries. In general, the undeveloped quality would be degraded if the number of administrative installations increases.

Context: There are currently no administrative installations within the Seney Wilderness. There is, however, a potential for such structures to be added in the future, creating the need for this measure in the framework.

Relevance to the indicator: Wilderness is set aside to retain its "primeval character" and ideally has no signs of human habitation. While it is necessary to mark wilderness boundaries and perhaps even erect gates to ensure its protection, these items are clear signs of human presence and therefore necessitate monitoring.

Data source: Wilderness Study, Wilderness Management Plan, professional judgment of Refuge staff

Process used to compile or gather the data: Review of the documents listed above and personal communications with Refuge staff.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Measure 20: Number of ditch plugs in place on Walsh Ditch within wilderness boundaries
Description: Monitored every five years. This measure is a count of the number of ditch plugs that have been installed inside wilderness boundaries. There are ditch plugs in place on Walsh Ditch both inside and outside of wilderness boundaries, but this measure includes only those on the component of Walsh Ditch that is inside wilderness. In general, the undeveloped quality would be degraded if the number of ditch plugs increases.

Context: The largest wetland drainage project in Michigan was initiated in 1912 near the town of Seney in the eastern Upper Peninsula of Michigan. This project included the construction of a series of drainage ditches intended to prepare the land for agricultural use. The largest of these ditches was the 22 mile-long Walsh Ditch, 6 miles of which runs north-south through the eastern side of the Seney Wilderness. In 2005, four earthen ditch plugs were installed along the length of the ditch found within the Seney Wilderness in an attempt to restore the hydrology and ecological integrity of the affected wetlands and streams. While these installations may degrade the undeveloped quality of wilderness, the restoration of wetlands is a highly respectable endeavor; both for the benefit of wilderness character and for overall landscape integrity.

Relevance to the indicator: Wilderness is a place where "the imprint of man's work [is] substantially unnoticeable." While the ditch plugs on Walsh Ditch are intended to benefit the natural quality of the wilderness by restoring wetlands, they still have an impact on the character of this wilderness.

Data source: Welsh 2011, Refuge GIS data

Process used to compile or gather the data: Review of the above data sources.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Indicator: Inholdings

Measure 21: Acres of inholdings
Definition: Monitored every five years. This measure calls for a sum of the total area (in acres) of any inholding(s) located within wilderness. In general, the undeveloped quality would be degraded if the acreage of inholdings increases.

Context: There are no private of public inholdings within the Seney Wilderness. This is unlikely to change given that the entire wilderness is under the control of the federal government and protected under the Wilderness Act of 1964. This measure has very low significance to this particular wilderness and has been included only in order to represent this indicator within the wilderness character monitoring framework.

Relevance to the indicator: A summation of the area of inholdings is directly linked to the indicator called "Inholdings". Many wilderness areas across the U.S. have acreages of privately or publicly owned land inside their borders. The use of this land can clearly and easily affect what happens inside that wilderness. It is therefore important to monitor the amount of land in these inholdings.

Data source: Professional judgment of Refuge staff

Process used to compile or gather the data: Personal communications with Refuge staff.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Monitoring question: What are the trends in mechanization inside wilderness?

Indicator: Use of motor vehicles, motorized equipment, or mechanical transport

Measure 22: Index of authorized motor vehicle, motorized equipment, or mechanical transport usage
Definition: Monitored annually. Each piece of equipment use within wilderness is placed into one of five categories and given a corresponding score as follows: mechanical transport (score = 1), low-impact motorized equipment (score = 2), high-impact motorized equipment (score = 3), low-impact motor

vehicle (score = 3), or high-impact motor vehicle (score = 4). The score for each category is then multiplied by the number of days of usage for any and all pieces of equipment that fall into that category. The products are added across categories to obtain the final index value. Scores on the index can range from 0 to 4,745. Further details can be viewed in Table 1, located in the Appendix section of this document. In general, the undeveloped quality would be degraded if the index score increases.

Context: While it has been very rare, significant use of motor vehicles and motorized equipment has occurred in the wilderness in the past. For instance, equipment was used to a great degree during the 1976 Seney Fire. More recently, large equipment was used inside wilderness (after minimum tool analysis) for the installation of the Walsh Ditch plugs in 2005 and chainsaws were used for fire dendrochronology studies in 2006. The 2011 index score for the Seney Wilderness is zero.

Relevance to the indicator: Wilderness is a place where "the imprint of man's work [is] substantially unnoticeable" and has been set aside to retain its primeval character. The use of motorized vehicles and equipment not only creates artificial and clearly man-made noise within the wilderness, but it also leaves behind significant signs of man's invasion into the wilderness. The use of mechanical transport disrupts the primeval character of wilderness. It prevents those who use or observe such equipment from being fully exposed to the wilderness and it serves as a stark reminder of man's presence.

Data source: Annual narratives, CCP, Wilderness Management Plan, Drobyshev papers, professional judgment of Refuge staff

Process used to compile or gather the data: Review of the documents listed above and personal communications with Refuge staff.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Measure 23: Number of known incidents of unauthorized motor vehicle or equipment usage

Definition: Monitored annually. This measure is a sum of known incidents of unauthorized equipment usage. Examples of such equipment would be ATVS or other off-road vehicles, chainsaws for cutting timber, etc. The law enforcement officer at the Refuge should have a very good idea of the number of such incidents. In general, the undeveloped quality would be degraded if the number of incidents of unauthorized motor vehicle equipment usage increases.

Context: There was an issue with this in the late 1980s according to the annual narratives (1985,1986, and 1987). The problem was not mentioned in later annual narratives, and has not been observed more recently by Refuge staff, so it is assumed that the issue has diminished. However, there is always a potential for such incidents to occur again.

Relevance to the indicator: As land set aside to retain its primeval character, it is critical that wilderness is not misused by visitors. The unauthorized use of vehicles inside wilderness is a severe hindrance to the maintenance of wilderness character, and therefore necessitates monitoring.

Data source: Annual narratives, professional judgment of Mr. Greg McClellan (Seney NWR Deputy Manager and law enforcement officer)

Process used to compile or gather the data: Review of annual narratives and personal communications with Greg McClellan.

Significant change: Any change in this measure will be considered significant.

Data adequacy: Medium. It is very difficult to know how many illegal intrusions have occurred with exact certainty.

Monitoring question: What are the trends in cultural resources inside wilderness?

Indicator: Loss of statutorily protected cultural resources

Measure 24: Number of disturbances to cultural resources

Description: Monitored every five years. This measure should simply be a count of the number of disturbances to statutorily protected cultural resources inside wilderness. Disturbances may include vandalism, construction, damage from wildlife, etc. In general, the undeveloped quality would be degraded if the number of disturbances to cultural resources increases.

Context: This is not a concern for the Seney Wilderness. This measure has very low significance to this particular wilderness and has been included only in order to represent this indicator within the wilderness character monitoring framework.

Relevance to the indicator: Recording the number of disturbances to cultural resources is directly linked to the indicator called "Loss of statutorily protected cultural resources". Many wilderness areas across the U.S. hold statutorily protected cultural resources. These cultural resources may be protected by law or agency policy. While cultural resources are often manmade structures, they are irreplaceable relics of a time when human history was intertwined with nature. They reflect the primeval character of wilderness and have often been in place for hundreds of years. They are a crucial part of human history and the wilderness' history as well. It is therefore important to monitor the degradation or disturbance of these resources by authorized, unauthorized, or natural means.

Data source: National Register of Historic Places

Process used to compile or gather the data: Review of the above data source.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION QUALITY

The document *Keeping It Wild* states the following regarding the solitude or primitive/unconfined recreation quality: The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality is about the *opportunity* for people to experience wilderness; it is not directly about visitor experiences per se. This quality is degraded by settings that reduce these opportunities, such as visitor encounters of modern civilization, recreation facilities, and management restrictions on visitor behavior.

Monitoring question: What are the trends in outstanding opportunities for solitude inside wilderness?

Indicator: Remoteness from sights and sounds of people inside the wilderness

Measure 25: Number of issued special use permits relating to wilderness
Definition: Monitored annually. This measure is a count of the number of permits issued for use of the wilderness area. This includes permits for camping, research, trapping, etc. In general, the solitude quality would be degraded if the number of special use permits increases.

Context: There were no special use permits issued for use of the Seney Wilderness in 2011. Permits have been issued in the past for multiple purposes, mostly related to research activities. Research is a priority at Seney NWR and there are often research projects that take place inside the wilderness. The research projects that have occurred inside the Seney Wilderness to date have been relatively low-impact and minimum tool analyses were always completed.

Relevance to the indicator: Research and other special uses of wilderness are often allowed for the purpose of increasing our knowledge of natural ecosystem functioning or for other important management practices. However, these special uses increase the number of people and signs of human presence inside wilderness, thus degrading one's ability to feel remote from the sights and sounds of people.

Data source: Professional judgment of Refuge staff, file of Special Use Permits issued in fiscal year 2011

Process used to compile or gather the data: Review of the data sources listed above.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Measure 26: Miles of drainage ditch inside wilderness
Definition: Monitored every five years. This is a measurement of the number of miles of Walsh Ditch (or future drainage ditch projects) that occur inside the wilderness boundary. Both increases and decreases in mileage should be monitored. In general, the solitude quality would be degraded if the miles of drainage ditch inside wilderness increase.

Context: There are currently six miles of drainage ditch that run through the Seney Wilderness. This number will not likely change in the near future. However, current and future efforts to plug the ditch and restore natural hydrological patterns to surrounding wetlands will hopefully have a positive impact on this measure in the long-run.

Relevance to the indicator: Wilderness is set aside to present outstanding opportunities for solitude. Remoteness from the sights of people implies remoteness not only from other humans, but from the work of humans as well. While Walsh Ditch was developed before wilderness designation, it still has a significant impact on the character of this wilderness. Additionally, if further wetland restoration efforts

ever occur they will be recorded under the untrammeled quality and it is important to capture the benefits of such actions as well. This necessitates monitoring.

Data source: Refuge maps, Refuge GIS data

Process used to compile or gather the data: Review of the data sources listed above.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Indicator: Remoteness from occupied and modified areas outside the wilderness

Measure 27: Miles of wilderness boundary adjacent to maintained roads

Definition: Monitored every five years. This is a measurement of the number of miles of wilderness boundary that run adjacent to maintained roads. This includes any maintained refuge roads, county roads, highways, etc. In general, the solitude quality would be degraded if the miles of wilderness boundary adjacent to maintained roads increase.

Context: Nearly half of the wilderness boundary (13.4 miles) runs adjacent to some sort of developed road. The most significant of these is Highway M-28 on the northern boundary. The presence of such developments is not in the control of management and therefore this measure cannot serve to inform future management decisions. However, this is still a significant issue within the context of monitoring the character of wilderness.

Relevance: The inclusion of a measure relating to remoteness from developed roads is critical to this indicator and the solitude quality. Roads can lead to a greater amount of visitor use, they create noise, and they are clear signs of human presence. All these factors affect the feelings of peace and calm necessary to attain a sense of solitude. The Seney Wilderness has very little recreation use, but this quality is aimed at tracking the amount of actual and *potential* use that a wilderness may have, as well as a visitor's opportunity to get away from occupied areas and feel truly remote. The areas of wilderness adjacent to roads, especially highways, would clearly influence such an opportunity. Recording the miles of wilderness boundary adjacent to maintained roads is meant to serve as a course representation of the areas that may not provide peace, calm, quiet, and remoteness.

Data source: Refuge GIS data (including Wilderness boundary, Seney NWR boundary, and "wild-adjacent_rds" layer)

Process used to compile or gather the data: ArcGIS software was used to calculate this measure. The wilderness layer and roads layer were added to a map. The roads layer was then clipped to those roads that are actually maintained based on outside knowledge along with the layer's attribute table. The "measure" tool was then used to calculate the distance (in miles) of wilderness boundary that runs adjacent to maintained roads.

Significant change: Any change in this measure will be considered significant.

Data adequacy: Medium. The Refuge GIS layers used to calculate data for this measure may not have been 100% accurate.

Measure 28: Percent of Seney Sand Lake Plain in protected lands

Description: Monitored every five years. This measure calls for the use of GIS software to calculate the percentage of total area within the Seney Sand Lake Plain that is legally protected from development. The Seney Sand Lake Plain is a sub-subsection of the eastern Upper Peninsula ecoregion. In general, the solitude quality would be degraded if the percent of Seney Sand Lake Plain in protected lands decreases.

Context: At present, 76% of the Seney Sand Lake Plain ecoregion is protected under federal, state, or private ownership for the benefit of wildlife or other natural resources. The character of the Seney Wilderness benefits from the undeveloped and remote country within which it is located.

Relevance: The large amount of protected land within the eastern U.P. creates a very remote atmosphere. The undeveloped, sparsely populated natural landscape provides peace and quiet, which fosters a sense of solitude.

Data source: PAD-US data, Refuge GIS data

Process used to compile or gather the data: The Protected Areas Database for the U.S. (PAD-US) was downloaded from the USGS GAP analysis website. This information was brought into ArcGIS 9.3 and overlaid on a shapefile of the Seney Sand Lake Plain. The PAD-US data was then clipped to the ecoregion shapefile and the area of protected lands was calculated. This was divided by the total area of the ecoregion and multiplied by 100 to obtain a percentage.

Significant change: A 5% change in this measure will be considered significant.

Data adequacy: High

Measure 29: Artificial night sky brightness

Definition: Monitored every ten years. This measure requires the use of an official artificial night sky brightness map to complete a visual examination of which brightness ratio category the area of the wilderness falls into. These maps are displayed such that colors correspond to ratios between the artificial night sky brightness and the natural night sky brightness of: <0.01 (black), 0.01-0.11 (dark gray), 0.11-0.33 (blue), 0.33-1 (green), 1-3 (yellow), 3-9 (orange), 9-27 (red), <27 (white). The Seney Wilderness falls entirely within the dark gray category, which implies a very low ratio of artificial brightness to natural brightness. This measure assigns a numerical value to each brightness ratio color class from best (black = 1) to worst (white = 8). Since the Seney Wilderness is in the second to lowest category it receives a 2.

If the wilderness ever falls into more than one artificial brightness category, the area of wilderness within each category should be calculated and converted to a percentage. For the purposes of this measure, the wilderness would be classified into whichever category holds the highest percentage of wilderness area, but the other categories and percentages should be marked down in the comments section of the database. In general, the solitude quality would be degraded if the artificial night sky brightness ratio increases (moves on the color scale from black toward white).

Context: The Seney Wilderness is in a very remote location, at least 80 miles from a town of significant size. There is therefore very little light pollution in the area, creating incredibly clear night skies. It is unlikely that local population levels or economic development will change dramatically in the near future, but developments such as communication towers can impact this measure as well. The global dataset used for this measure were developed in 2000 and it is uncertain when such a project will be repeated. In order to continue monitoring night sky brightness, the Refuge could consider purchasing a handheld Sky Quality Meter (SQM) for approximately $120.00 which would allow data to be collected at a much more local scale. The SQM measures the brightness of the night sky in magnitudes per square arcsecond. If the Refuge decides to start collecting data in this way, a protocol should be written up and entered into the database to ensure consistency.

Relevance to the indicator: This indicator is aimed at monitoring the condition of areas surrounding wilderness that may affect a visitor's opportunities for solitude. Although land managers cannot control these external factors, they can sometimes have significant impacts on wilderness character. Night sky visibility is a component of the social meanings we place on wilderness. Wilderness values such as humility, restraint, and interdependence are critical aspects of wilderness character, so the extent of one's ability to experience them must be monitored.

Data source: Cinzano et al. (2000) and The Night Sky in the World website

Process used to compile or gather the data: Interpretation of Cinzano's article and visual classification of the Seney Wilderness based on a wilderness boundary layer overlaid on an artificial night sky brightness map in ArcGIS.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Monitoring question: What are the trends in outstanding opportunities for primitive and unconfined recreation inside wilderness?

Indicator: Facilities that decrease self-reliant recreation

Measure 30: Number of agency-provided recreational facilities

Definition: Monitored annually. This measure is a count of such things as trails, trail markings, shelters, water sources, restrooms, picnic tables, bear boxes, designated campsites, etc. In general, the primitive and unconfined recreation quality would be degraded if the number of agency-provided recreational facilities increases.

Context: This is not an issue in the Seney Wilderness. There are no facilities provided in the Seney Wilderness at present and it is stated in the Wilderness Management Plan that no recreation facilities will be developed in the future. This measure has low relevance to this particular wilderness and has been included only in order to represent this indicator within the wilderness character monitoring framework.

Relevance: *Keeping It Wild* states that "opportunities for primitive and unconfined recreation are most outstanding where visitors must rely on their own skills to navigate, travel, and live…" This measure is aimed at tracking a visitor's opportunity to fully experience wilderness. Structures, installations, or developments that have a recreation purpose degrade a visitor's perceived opportunity for primitive and unconfined recreation, and thus necessitate monitoring.

Data source: Wilderness Study, Wilderness Management Plan, Refuge staff

Process used to compile or gather the data: Review of the documents listed above and personal communications with Refuge staff.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

Indicator: Management restrictions on visitor behavior

Measure 31: Index of management restrictions on visitor behavior

Description: Monitored annually. This measure is a weighted index of restrictions on visitor behavior. Scores range from 0 to 3 based on the type of restriction for each of 10 regulation categories. These scores are then weighted by geographic extent, where a weight of 1 applies to a restriction that covers only a subarea of the wilderness, and a weight of 2 applies to a restriction that is wilderness-wide. Scores for each regulation category are multiplied by their geographic extent. These products are then summed across all categories. Scores on the index can range from 0 to 36. Further details can be viewed in Table 2, located in the Appendix section of this document. In general, the primitive and unconfined recreation quality would be degraded if the index score of management restrictions increases.

Context: Management restrictions on visitor behavior are a complex issue in the Seney Wilderness. Most recreational activities are prohibited in the wilderness, but this is because they are incompatible with the Refuge's establishing purposes of putting wildlife first. While this has degraded opportunities for primitive recreation, it has preserved the natural quality and helped to maintain a sense of solitude for those that do visit the wilderness. The 2011 index score for the Seney Wilderness is twelve.

Relevance to the indicator: The extent of management restrictions on visitor behavior is an important component of primitive and unconfined recreation. It relates to the ability to experience freedom of choice and to exercise a high degree of freedom over one's actions and decisions. *Keeping It Wild* states that "visitors' opportunities to experience freedom from management are significantly affected by the number and type of regulations in place." The type and extent of these regulations require monitoring.

Data source: Seney NWR website, Seney NWR brochure, Seney NWR Hunting Regulations and Map, Refuge staff

Process used to compile or gather the data: Review of the data sources listed above and personal communications with Refuge staff.

Significant change: Any change in this measure will be considered significant.

Data adequacy: High

MEASURES NOT USED

UNTRAMMELED QUALITY

Number of manipulations to Walsh Ditch
Reason: This measure was expanded to become Measure 4 (number of actions taken to restore natural hydrology to the landscape). The wording used more directly approaches the trammeling aspects of manipulations to Walsh Ditch. The placement of actual ditch plugs in the wilderness is accounted for in Measure 20 (number of ditch plugs in place on Walsh Ditch within wilderness boundaries).
Priority ranking: High

Number of authorized research projects within wilderness
Reason: It was decided that the aspects of research that cause trammeling would be accounted for under the other measures listed in this quality. Any developments for research purposes should be accounted for under Measure 22 (the index of authorized motor vehicle, motorized equipment, or mechanical transport usage in the undeveloped quality). The presence of researchers within wilderness should be accounted for under Measure 25 (number of issued special use permits relating to wilderness).
Priority ranking: Medium

NATURAL QUALITY

Number of indigenous species that are listed as threatened/endangered/sensitive
Reason: There was no readily available data for this measure. Given its low priority level for the Seney Wilderness, it would not have been worth the time and effort to develop a system for accurately calculating this measure.
Priority ranking: Low

Number of extirpated indigenous species
Reason: There was no readily available data for this measure. Given its low priority level for the Seney Wilderness, it would not have been worth the time and effort to develop a system for accurately calculating this measure.
Priority ranking: Low

Change in water quality
Reason: There was no readily available data for this measure. It was also assigned a low priority level because Seney NWR is located near the top of its watershed and its water is known to be relatively high quality. It would therefore not have been worth the time and effort to develop and carry out a water sampling protocol.
Priority ranking: Low

Extent of human-caused stream sedimentation
Reason: Studies have shown that sedimentation is occurring in Refuge water bodies, but there is no data relating to sedimentation inside wilderness boundaries. Refuge staff has no plans for such data to be gathered in the near future.

Priority ranking: Medium

Total summer evapotranspiration
Reason: This was originally part of the suite of weather data measures being used in an attempt to gather information on climate change influences at a local level. Although changes in evapotranspiration rates are a relatively strong indicator of climate change effects, this measure was removed for several reasons. The RAWS weather data being used was missing evapotranspiration data for far more days than any of the other parameters being recorded. It was also removed because there is significant debate regarding the most accurate way to calculate this physical process.
Priority ranking: Medium

Acres of wetland restored due to Walsh Ditch restoration efforts
Reason: There is no data for such a measure. Greater knowledge of the positive impacts of wetland restoration activities would be a helpful management tool, but this would require a time-intensive and in-depth research study. Refuge staff does not have the resources to take on this type of study at present.
Priority ranking: Medium

Loss of connectivity with the surrounding landscape
Reason: There was no data for this measure and the development of an appropriate process for measuring connectivity in a straightforward way proved very complex. Additionally, this measure was assigned a low priority level for the Seney Wilderness due to the high percentage of protected lands that surround the Refuge.
Priority ranking: Low

UNDEVELOPED QUALITY

Number of old logging camp structures
Reason: Primitive logging camps were built in the wilderness before its designation, but their number and location have never been established. It would take significant man-hours to search out these sites. It would not be worthwhile to spend resources on such an effort given this measure's low priority to the Seney Wilderness.
Priority ranking: Low

SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION QUALITY

Amount of visitor use
Reason: There is no data for this measure. Visitor usage is a relatively important component of the solitude quality, thus the priority level assigned to this measure. However, there is no system in place to collect this type of information.
Priority ranking: Medium

Number of trail contacts
Reason: There are no trails in the wilderness nor will there be in the future. This measure has no relevance to the Seney Wilderness.
Priority ranking: Low

Number of campsites

Reason: There are no campsites in the wilderness nor will there be in the future. This measure has no relevance to the Seney Wilderness.
Priority ranking: Low

Extent and magnitude of intrusions on the natural soundscape
Reason: There is no data for this measure and Refuge staff has no plans for such data to be gathered in the near future.
Priority ranking: Medium

Number of user-created recreation facilities
Reason: There is no data for this measure. The number of user-created facilities is a relatively important component of the solitude quality, but there is no system in place to collect this type of information. It may not be worthwhile to develop such a system at present given that the only likely facilities being developed inside wilderness are temporary hunting blinds and other structures of that nature.
Priority ranking: Low

CONCLUSIONS

A robust set of wilderness character monitoring measures were developed for Seney NWR between September and November 2011. The measures emphasize the Refuge's landscape-level management goals and their associated research. The measures also identify significant management activities occurring in wilderness, including wetland restoration and fire management. While the measures discussed in this document cannot possibly provide a complete picture of Seney's issues and resources, they capture an excellent snapshot of this 25,150-acre wilderness.

The overall condition of the Seney Wilderness is excellent. Refuge management has exerted significant effort to keep the natural systems intact and to allow most natural processes to function freely. The Seney Wilderness requires relatively few management actions, and very little recreational use occurs within its boundaries due to its remote nature. The chances of unauthorized actions taking place or of facilities being developed inside wilderness are therefore very slim.

The system of monitoring used for this project highlights a concern for the Seney Wilderness. I have recorded various aspects of the impacts and management actions relating to Walsh Ditch in 8 of the 31 measures. Walsh Ditch was developed prior to Seney's wilderness designation, forcing Refuge management to deal with its existence and inclusion as part of federally-designated wilderness. Refuge management chose to install earthen ditch plugs on Walsh Ditch with the intent of mitigating the ditch's damage to surrounding wetlands, while minimizing further degradation of wilderness character. However, certain degradations to both the undeveloped and untrammeled qualities were unavoidable in the process of the restoration project, making it difficult to balance the project's impacts and benefits among the four qualities of this monitoring system. While wetland restoration is an important and admirable goal, so the inclusion of data regarding the amount/area of wetlands restored would be helpful within this particular monitoring framework. This would more explicitly display the restoration project's benefits to the natural quality, thus offsetting the degradations it causes to the undeveloped and untrammeled qualities.

I believe that the wilderness character monitoring plan laid out in this document has taken into account many of the issues unique to the Seney Wilderness; may they be positive, negative, or neutral. The plan

accounts for certain necessary degradations to one aspect of wilderness character by recording the positive results of such actions under another aspect. The plan responds to all nationally required wilderness character indicators, while taking care to include only measures that are actually relevant within the unique set of conditions at the Seney Wilderness. Additionally, the plan only uses data that is already routinely collected or is very simple to collect and analyze.

It should be noted that, at first glance, the undeveloped and solitude qualities may seem less represented than the untrammeled or natural qualities. This was not done purposely for any type of bias among the four measures. The only reasons for this discrepancy are a lack of data sources and a lack of need. As for the former, there is no data, nor any system in place to collect data, on visitation to the wilderness, soundscape monitoring, or user-created recreation facilities. As for the latter, the time and effort of Refuge staff would not be well spent collecting data on such things as recreational campsites, old logging camps, or trails inside wilderness because these items either do not exist or do not have an impact in the Seney Wilderness. If for any reason these circumstances change, measures to represent their effects on wilderness character should be developed and entered into this framework.

In order to augment the areas where data were somewhat lacking, the following potential projects would benefit wilderness character monitoring in the future:

- Initiation of a soundscape monitoring project
- Continuation of night sky brightness monitoring by purchasing a Sky Quality Meter (see Measure 27)
- Initiation of a protocol for estimating wilderness visitation (e.g. inquiring of visitors as to whether they will be visiting the wilderness when they come to the headquarters to obtain a gate key)
- Initiation of a protocol for estimating the number of user-created recreation facilities inside wilderness (e.g. hunting blinds)
- Initiation of a study regarding the amount/area of wetlands restored inside wilderness due to restoration efforts on Walsh Ditch
- Initiation of projects to improve wilderness awareness (e.g. brochures, kiosks, wilderness workshops etc.)

While data from these projects would certainly aid in wilderness character monitoring, it is also understood that Refuge staff time is limited and is often stretched too thin. The addition of these projects may not be feasible in the near future, but they are nonetheless things to consider. Whether these projects are pursued or not, the primary conclusion that can be drawn from this project is that the Seney Wilderness is an excellent representation of wilderness qualities and values.

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Management Planning 010.035.035
History 010.035.020
String Bogs 080.070.010
Strangmoor Bog 080.030.014
Annual Narratives (1970-1972, 1976, 1978, 1981-1989)

WILDERNESS CHARACTER MONITORING RESOURCES:

Landres et al. 2008. Keeping It Wild: An Interagency Strategy to Monitor Trends in Wilderness Character Across the National Wilderness Preservation System. US Department of Agriculture, Forest Service: General Technical Report RMRS-GTR-212.

Landres et al. 2009. Technical Guide for Monitoring Selected Conditions Related to Wilderness Character. US Department of Agriculture, Forest Service: General Technical Report WO-80.

WEBSITES:

The Night Sky in the World website:
www.lightpollution.it/dmsp/

The Protected Areas Database for the U.S. (PAD-US) from the USGS GAP analysis website:
http://gapanalysis.usgs.gov/data/padus-data/padus-data-download/

National Register of Historic Places website:
http://nrhp.focus.nps.gov/natreghome

Seney RAWS Data website:
http://www.raws.dri.edu/cgi-bin/rawMAIN.pl?ncMSEN

Seney NWR website:
http://www.fws.gov/midwest/seney/

APPENDICES

WORKSHEETS: PRIORITIZING MEASURES OF WILDERNESS CHARACTER

In each row, write the indicator and potential measure in the left column. Use the following criteria and ranking guide to create an overall score for each measure. Those measures with the highest overall scores should be the highest priority for assessing trends in wilderness character.

- Level of importance: measure is highly relevant to the quality and indicator of wilderness character, and is highly useful for managing the wilderness. High = 3, Medium = 2, Low = 1
- Level of vulnerability: measures the level to which an attribute of wilderness character is currently at risk or might likely be at risk over the next 10-15 years. High = 3, Medium = 2, Low = 1
- Degree of reliability: measure can be monitored accurately with a high degree of confidence and would yield the same result if measured by different people at different times. High = 3, Medium = 2, Low = 1
- Degree of reasonableness: measure is related to an existing effort or could be monitored without significant additional effort. High = 1, Low = 0

QUALITY: UNTRAMMELED

Potential Measure	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	Importance	Vulnerability	Reliability	Reasonableness	
Indicator: Actions authorized by the Federal land manager that manipulate the biophysical environment Measure: Number of actions taken to manage invasive species	3	3	3	1	10
Indicator: Actions authorized by the Federal land manager that manipulate the biophysical environment Measure: Number of actions taken that trammel animal species in wilderness (including actions for surveys or research)	2	1	2	1	6
Indicator: Actions authorized by the Federal land manager that manipulate the biophysical environment Measure: Number of actions taken to manage fire	3	3	3	1	10

Potential Measure	Criteria for Prioritizing Potential Measures: Importance	Vulnerability	Reliability	Reasonableness	OVERALL SCORE
Indicator: Actions authorized by the Federal land manager that manipulate the biophysical environment Measure: Number of actions taken that manipulate Walsh Ditch	3	3	3	1	10
Indicator: Actions authorized by the Federal land manager that manipulate the biophysical environment Measure: Number of authorized research projects within wilderness	1	2	3	1	7
Indicator: Actions ***not authorized*** by the Federal land manager that manipulate the biophysical environment Measure: Number of unauthorized actions by agencies, citizen groups, or individuals that manipulate biotic or abiotic communities inside wilderness	2	1	1	1	5

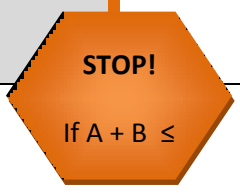
STOP!

If A + B ≤ 2

QUALITY: NATURAL

Potential Measure	Criteria for Prioritizing Potential Measures: Importance	Vulnerability	Reliability	Reasonableness	OVERALL SCORE
Indicator: Plant and animal species and communities Measure: Number of indigenous species that are listed as threatened, endangered, sensitive, or of concern	2	1	2	0	5
Indicator: Plant and animal species and communities Measure: Number of extirpated indigenous species	2	1	2	0	5

Potential Measure	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	Importance	Vulnerability	Reliability	Reasonableness	
Indicator: Plant and animal species and communities Measure: Number of indigenous and/or non-indigenous invasive species	3	1	2	1	6
Indicator: Plant and animal species and communities Measure: Change in demography/composition/ structure of each LTA inside wilderness	3	3	2	1	9
Indicator: Physical resources Measure: Extent and magnitude of change in water quality	2	1	2	0	5
Indicator: Physical resources Measure: Extent of human-caused stream sedimentation	2	2	2	0	6
Indicator: Biophysical processes Measure: Extent and magnitude of global climate change/weather patterns	2	2	2	1	7
Indicator: Biophysical processes Measure: Deviation from the pre-European-settlement fire return interval of 50-60 years	3	2	3	1	9
Indicator: Biophysical processes Measure: Acres of wetland restored due to Walsh Ditch restoration efforts inside wilderness	3	3	2	0	8
Indicator: Biophysical processes Measure: Area and magnitude of loss of connectivity with the surrounding landscape	3	1	1	0	5



QUALITY: UNDEVELOPED

Potential Measure	Criteria for Prioritizing Potential Measures				OVERALL SCORE
	Importance	Vulnerability	Reliability	Reasonableness	
Indicator: Non-recreational structures, installations, and developments Measure: Miles of drainage ditch inside wilderness	3	3	3	1	10
Indicator: Non-recreational structures, installations, and developments Measure: Number of old logging camp structures	2	1	1	0	4
Indicator: Non-recreational structures, installations, and developments Measure: Number of administrative installations- signs, gates, etc.	2	1	3	1	7
Indicator: Non-recreational structures, installations, and developments Measure: Number of drainage ditch plugs in place on Walsh Ditch inside wilderness	3	3	3	1	10
Indicator: Inholdings Measure: Area of inholdings (acres) inside wilderness	1	1	3	1	6
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport Measure: Index of motor vehicle, motorized equipment, or mechanical transport usage authorized by the federal government	3	1	3	1	8
Indicator: Use of motor vehicles, motorized equipment, or mechanical transport Measure: Number of known instances of unauthorized motor vehicle or equipment usage inside wilderness	3	1	1	1	6

Potential Measure	Criteria for Prioritizing Potential Measures: Importance	Vulnerability	Reliability	Reasonableness	OVERALL SCORE
Indicator: Loss of statutorily protected cultural resources Measure: Number of disturbances to cultural resources	1	1	3	1	6

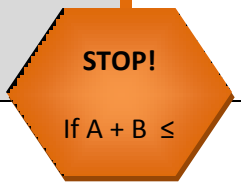
STOP!

If A + B ≤

QUALITY: SOLITUDE OR PRIMITIVE AND UNCONFINED RECREATION

Potential Measure	Criteria for Prioritizing Potential Measures: Importance	Vulnerability	Reliability	Reasonableness	OVERALL SCORE
Indicator: Remoteness from sights and sounds of people inside the wilderness Measure: Amount of visitor use	2	1	2	1	6
Indicator: Remoteness from sights and sounds of people inside the wilderness Measure: Number of trail contacts	1	1	3	1	6
Indicator: Remoteness from sights and sounds of people inside the wilderness Measure: Number of campsites	1	1	3	1	6
Indicator: Remoteness from sights and sounds of people inside the wilderness Measure: Number of issued special use permits	2	1	3	1	7
Indicator: Remoteness from occupied and modified areas outside the wilderness Measure: Miles of wilderness boundary adjacent to maintained roads	2	3	3	1	9
Indicator: Remoteness from occupied and modified areas outside the wilderness	3	2	3	1	9

Potential Measure	Criteria for Prioritizing Potential Measures				
	Importance	Vulnerability	Reliability	Reasonableness	OVERALL SCORE
Measure: Percent of Seney Sand Lake Plain in protected lands					
Indicator: Remoteness from occupied and modified areas outside the wilderness Measure: Artificial night sky brightness averaged over the wilderness	3	1	2	1	7
Indicator: Remoteness from occupied and modified areas outside the wilderness Measure: Extent and magnitude of intrusions on the natural soundscape	2	2	2	0	6
Indicator: Facilities that decrease self-reliant recreation Measure: Number of agency-provided facilities	2	1	3	1	7
Indicator: Facilities that decrease self-reliant recreation Measure: Number of user-created facilities	2	2	1	0	5
Indicator: Management restrictions on visitor behavior Measure: Index of management restrictions on visitor behavior	2	2	3	1	8



MAP 1: Ecological and geographic setting of the Seney Wilderness, displaying Land Type Associations of the Seney Sand Lake Plain sub-subsection of the Eastern Upper Peninsula ecoregion.

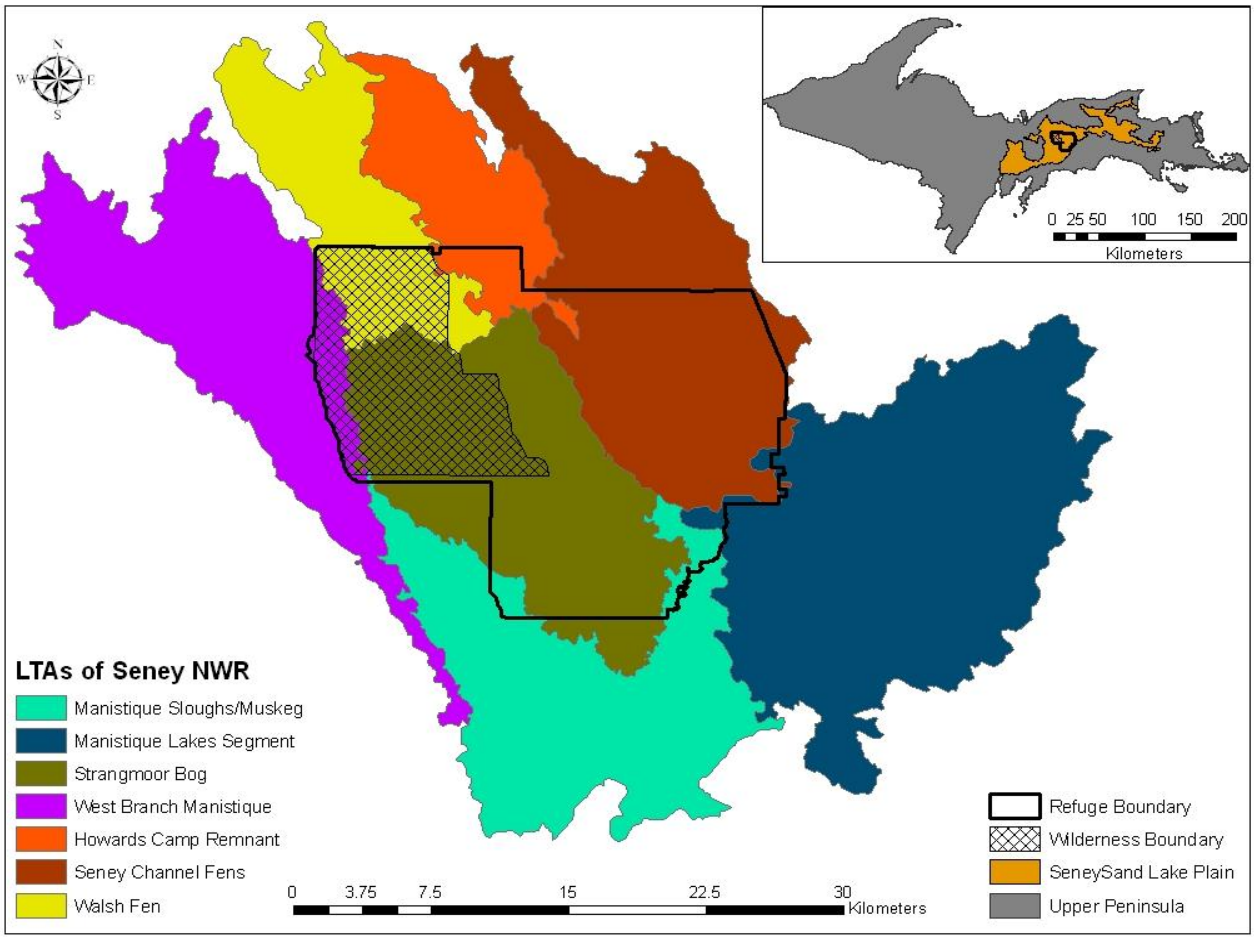


TABLE 1: Index of authorized motor vehicle, motorized equipment, or mechanical transport usage

Authorized Use- 2011				
Type of equipment	**Examples (not all-inclusive)**	**Score**	**Days of Usage**	**Index Value**
Mechanical Transport		1	0	0
	bicycle			
	Game/canoe cart			
	wheelbarrow			
Motor Vehicle- low impact		3	0	0
	truck/car/motorcycle etc.			
	track vehicle (Marsh-master, bombardier, Scout, Kubota, etc.)			
	recreational vehicle (ATV, snowmachine, etc.)			
	fixed-wing aircraft			
	float plane			
	helicopter			
Motor Vehicle- high impact		4	0	0
	heavy equipment			
	concrete equipment			
	construction vehicles			
Motorized Equipment- low impact		2	0	0
	portable pump			
	generator			
	battery-powered tool			
Motorized Equipment- high impact		3	0	0
	rock drill			
	chain saw			
			Total Score	0

TABLE 2: Index of management restrictions on visitor behavior

Category	**Type of Restriction**	**Score**	**Geographic Weight** (1 = subarea, 2 = entire wilderness)	**Index Score**
Small game hunting (during state season)	No restrictions	0		
	Permitted but restricted	1	1	1
	Not permitted	2		
Big game hunting (during state season)	No restrictions	0		
	Permitted but restricted	1	1	1
	Not permitted	2		
Hunting with dogs	No restriction	0		
	Permitted but restricted	1	2	2
	Prohibited	2		
Fees	No fees	0	2	0
	Fees charged of selected user type	1		
	Fees charged of all visitors	2		
Permits for general use	No permit or registration	0	2	0
	Voluntary self-registration	1		
	Mandatory; nonlimiting registration	2		
	Mandatory; use limited	3		
Human waste	No regulation	0	2	0
	Pack out required	1		
Length of stay	No restrictions	0		
	Length of stay limited	1	2	2
Group size limit	No restrictions	0	2	0
	Group size limits in place	1		
Dogs/domesticated animals	No restrictions	0		
	Required to be on leash	1	2	2
	Prohibited	2		
Camping during hunting season	No restrictions	0		
	Permit required	1		
	Prohibited	2	2	4
			Total Score =	12

TABLE 3: Description of data sources and how the data were gathered

Measure	Priority (H, M, L)	Detailed Description of the Data Source(s) and How the Data Were Gathered
Untrammeled Quality		
Number of actions taken to manage invasive species	H	2011 Invasive Plant Management Report, CCP, MNFI Strangmoor Bog Assessment, Forest Rapid Ecological Assessment
Number of naturally-started fires that received a suppression response	H	Annual narratives, Refuge staff, CCP
Number of prescribed burns	H	Annual narratives, Refuge staff, CCP
Number of actions taken to restore natural hydrology of the wilderness	H	Environmental Assessment of Marsh and Walsh Creek Restoration, 2011 thesis by S.P. Welsh
Number of actions taken that influence animal populations	M	Refuge staff, review of MRAs and Special Use permits
Number of known incidents of unauthorized actions that influence the biotic and/or abiotic community	L	Refuge staff (LE officer)
Natural Quality		
Number of indigenous and/or non-indigenous invasive species	M	Forest Rapid Ecological Assessment, MNFI Ecological Community Field Survey, CCP, 2011 Invasive Plant Management Report, Refuge staff
Dominant tree species within West Branch Manistique LTA	H	Forest Rapid Ecological Assessment
Percent wetland land cover within Strangmoor Bog LTA	H	2006 National Land Cover Dataset, Wilderness boundary shapefile, LTA shapefile
Percent forest land cover within Strangmoor Bog LTA	H	2006 National Land Cover Dataset, Wilderness boundary shapefile, LTA shapefile
Percent wetland land cover within Walsh Fen LTA	H	2006 National Land Cover Dataset, Wilderness boundary shapefile, LTA shapefile
Percent forest land cover within Walsh Fen LTA	H	2006 National Land Cover Dataset, Wilderness boundary shapefile, LTA shapefile
Air quality measures	N/A	I&M Program
Mean summer temperature	M	RAWS weather data

Mean winter temperature	M	RAWS weather data
Average annual precipitation	M	RAWS weather data
Deviation from the pre-European-settlement fire return interval	H	Drobyshev et al. 2008
Deviation from the pre-European-settlement fire cycle	H	Drobyshev et al. 2008
Undeveloped Quality		
Number of administrative installations	M	Wilderness Study, Wilderness Management Plan, Refuge staff, Refuge GIS data
Number of ditch plugs in place on Walsh Ditch within wilderness boundaries	H	Welsh 2011, Refuge GIS data
Acres of inholdings	L	Refuge staff
Index of authorized motor vehicle, motorized equipment, or mechanical transport usage	M	Annual narratives, CCP, Wilderness Management Plan, Refuge staff
Number of known incidents of unauthorized motor vehicle or equipment usage inside wilderness	M	Annual narratives, Refuge staff (LE officer)
Number of disturbances to cultural resources	L	National Register of Historic Places, Wilderness Study, Wilderness Management Plan
Solitude or Primitive and Unconfined Quality		
Number of issued special use permits relating to wilderness	M	Refuge staff (LE officer), review of file containing all administered Special Use Permits for 2011
Miles of drainage ditch inside wilderness	H	Refuge maps, GIS data
Miles of wilderness boundary adjacent to maintained roads	H	GIS data: Wilderness boundary, Seney NWR boundary, and a layer named “wild-adjacent_rds” (created by clipping a county roads layer to the wilderness boundary)
Percent of Seney Sand Lake Plain in protected lands	H	The Protected Areas Database, along with simple analysis in ArcGIS 9.3
Artificial night sky brightness	M	P. Cinzano, F. Falchi (University of Padova), C. D. Elvidge (NOAA National Geophysical Data Center, Boulder). Copyright Royal Astronomical Society.
Number of agency-	M	Wilderness Study, Wilderness Management Plan, Refuge staff

provided recreational facilities		
Index of management restrictions on visitor behavior	M	Seney website, Seney NWR brochure and Seney NWR Hunting Regulations brochure, Refuge staff

TABLE 4: Effort required per measure for wilderness character monitoring

Quality	Indicator	Measure	Were data gathered from office paper files, computer files, or field work (professional judgment is an option)?	Time you spent locating available data sources (in whole hours)	Time you spent gathering data for each measure (in whole hours)
Untrammeled	Authorized actions	Number of actions taken to manage invasive species	electronic and paper files	1	2
Untrammeled	Authorized actions	Number of naturally-started fires that received a suppression response	paper files, professional judgment	2	2
Untrammeled	Authorized actions	Number of prescribed burns	paper files, professional judgment	2	2
	Authorized actions	Number of actions taken to restore natural hydrology of the wilderness	electronic and paper files	2	4
Untrammeled	Authorized actions	Number of actions taken that influence animal populations	paper files, professional judgment	1	1
Untrammeled	Unauthorized actions	Number of known incidents of unauthorized actions that influence the biotic/abiotic community	professional judgment	1	1
Natural	Plant and animal species	Number of indigenous and/or non-indigenous invasive species	electronic and paper files, professional judgment	1	2

Natural	Plant and animal species	Dominant tree species within West Branch Manistique LTA	electronic files	1	1
Natural	Plant and animal species	Percent wetland land cover within Strangmoor Bog LTA	GIS files and analysis	3	1
Natural	Plant and animal species	Percent forest land cover within Strangmoor Bog LTA	GIS files and analysis	3	1
Natural	Plant and animal species	Percent wetland land cover within Walsh Fen LTA	GIS files and analysis	2	1
Natural	Plant and animal species	Percent forest land cover within Walsh Fen LTA	GIS files and analysis	2	1
Natural	Physical resources	Air quality measures	N/A		
Natural	Biophysical processes	Mean summer temperature	RAWS station data (computer files), Excel analysis	2	3
Natural	Biophysical processes	Mean winter temperature	RAWS station data (computer files), Excel analysis	1	3
Natural	Biophysical processes	Average annual precipitation	RAWS station data (computer files), Excel analysis	1	3
Natural	Biophysical processes	Deviation from the pre-European-settlement fire return interval	electronic files	2	2
Natural	Biophysical processes	Deviation from the pre-European-settlement fire cycle	electronic files	2	2

Undeveloped	Non-recreational structures, installations, and developments	Number of administrative installations	paper files, GIS files	1	2
Undeveloped	Non-recreational structures, installations, and developments	Number of ditch plugs in place on Walsh Ditch within wilderness boundaries	electronic files, GIS files	2	2
Undeveloped	Inholdings	Acres of inholdings	professional judgment	1	1
Undeveloped	Use of motorized or mechanical	Index of authorized motor vehicle, motorized equipment, or mechanical transport usage	electronic and paper files, professional judgment	2	3
Undeveloped	Use of motorized or mechanical	Number of known incidents of unauthorized motor vehicle or equipment usage inside wilderness	paper files, professional judgment	2	2
Undeveloped	Loss of cultural resources	Number of disturbances to cultural resources.	paper files, online resources	1	1
Solitude +	Remoteness from inside	Number of issued special use permits relating to wilderness	paper files, professional judgment	1	2
Solitude +	Remoteness from inside	Miles of drainage ditch inside wilderness	GIS files	1	1
Solitude +	Remoteness from outside	Miles of wilderness boundary adjacent to maintained roads	GIS files	2	2

Solitude +	Remoteness from outside	Percent of Seney Sand Lake Plain in protected lands	online resources, GIS analysis	5	5
Solitude +	Remoteness from outside	Artificial night sky brightness	paper	5	5
Solitude +	Facilities that decrease self-reliant recreation	Number of agency-provided recreational facilities	paper files	1	2
Solitude +	Mgmt restrictions on visitor behavior	Index of management restrictions on visitor behavior	paper files	2	3